BIOLOGICAL ASSESSMENT OF THE FRESHWATER MUSSELS IN THE KENTUCKY DAM TAILWATERS OF THE TENNESSEE RIVER

by

James B. Sickel
Hancock Biological Station
Department of Biological Sciences
Murray State University
Murray, Kentucky 42071

Submitted to

Kentucky Division of Water
Department for Environmental Protection
Natural Resources and Environmental Protection Cabinet
Frankfort, Kentucky 40601

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Errata

1. Page 22. Species 26. Columns beginning with River Mile 18.2 through 17.6, should read 1 -17 - 6 - 38 - 2 - 1.

2. Page 27. Bottom line of Table 4 should read Total Density No./m^2.

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ABSTRACT

From June 16 to August 22, 1985, a survey of the freshwater mussels was conducted in the Tennessee River from Kentucky Dam at mile 22.4 to the Ohio River. Brailing and SCUBA diving were employed at 51 sites resulting in the collection of 4,384 mussels and varification of 36 species--all but 2 being found alive. Fusconaia ebena was the most abundant mussel comprising 35% of the total with the other common species being Amblema plicata (12%), Quadrula pustulosa (11%), Pleurobema cordatum (7%), Cyclonaias tuberculata (6%), and Plagiola lineolata (5%). Two species on the federal endangered species list were found, photographed, and returned alive. These were Lampsilis orbiculata (2 specimens at mile 14.7) and Plethobasus cooperianus (3 specimens at mile 20.6). There was no evidence of recent successful reproduction or recruitment in either of the endangered species. Unless efforts are taken to revitalize populations of these two species, they are doomed to extirpation from the lower Tennessee River. A recovery project should be initiated immediately. Recruitment of young mussels was evident in most of the common species including Pleurobema cordatum and Quadrula cylindrica. Growth rates of Fusconaia ebena as indicated by age, length and weight measurements were lowest at two sites downstream from the industrial outfalls at mile 15, however, factors other than the location of the outfalls may account for the lower growth rates. The predominance of young mussels at those sites indicates a mussel kill occurred 8-10 years ago. This was inferred as well from information provided by commercial musselers. However, the existing high quality shells and large numbers of mussels below the outfalls indicate an

improvement in environmental conditions condusive to mussel surival. If environmental conditions can be kept from deteriorating below their present level and continually improved as improvements are feasible, it is believed that the Kentucky Dam tailwaters will continue to support a healthy, diverse mussel fauna. The following recommendations are presented as a means of preserving endangered species and a healthy, diverse mussel fauna in the Kentucky Dam Tailwaters: (1) Prevent further deterioration of environmental conditions; (2) Strive for continued improvement in water quality as improvements become feasible; (3) Initiate an endangered species recovery program; (4) Maintain and protect the mussel sanctuary, TRM 17.8-22.4, from commercial musseling or other activities that might disturb the mussel beds.

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Biological Assessment of the Freshwater Mussels in the Kentucky Dam Tailwaters of the Tennessee River

INTRODUCTION

In 1984 the Kentucky Division of Water proposed to reclassify the Kentucky Dam tailwater section of the Tennessee River, mile 0 - 22.4, as an Outstanding Resource Water in compliance with the Kentucky Water Quality Regulations, 401 KAR 5:031 Section 8 of Surface Water Standards. One basis for this classification was the known occurrence in the river of freshwater mussel species listed on the Federal Endangered Species List. The presence of endangered species automatically includes the section of the river in question in the Outstanding Resource Water classification. However, because the most recent documentation of endangered species in the Kentucky Dam tailwaters was based on shells found in a commercial musseler's catch, industrial users of the surface waters were justified in their request to delay classification until proof could be provided that living individuals of endangered species still existed in the river. The primary purpose of this report is to document the presence of endangered species in the Kentucky Dam tailwater section of the Tennessee River. In addition to this, the study reported here was designed to determine the locations of mussel beds, and the density, species composition, population age structure, and age and growth relationships of selected mussels in the river.

Historically, the Tennessee River and its tributaries have supported the

largest assemblage of mussels known anywhere in the world. During the early 20th century, before dams were constructed on the Tennessee River, records from scientific collections demonstrated the uniqueness of this mussel fauna. As agricultural, forestry, industrial and municipal developments increased and eventually dam construction was initiated, the demise of several species ensued, and many other species have become so restricted in their distribution as to be on the verge of extinction (Stansbery, 1970). Many of the surviving species are endangered because they have been unable to adapt to the environmental changes induced by man. In this respect, endangered species serve as indicators of environmental alteration and degradation. Change is natural, but when the environmental change is of such magnitude as that occurring today caused by man's activities the results are unpredictable and may be detrimental to man's own survival. Perhaps the attempt to preserve endangered species may slow the environmental degradation and allow time to learn the consequences of this degradation or to find ways to prevent it.

Mussels move very little after reaching the adult stage. Once located in a mussel bed they may remain there for the duration of their life span of up to fifty years. Because they cannot leave an area such as fish may do, mussels are useful indicators of chronic environmental conditions, particularly with respect to bioaccumulation of potentially toxic substances.

During the early 1970's a growing concern over the extinction of a number of mussel species and the near extinction of many more led to the designation of 24 species as endangered by the federal government (U.S. Fish and Wildlife Service, 1976). Two of these species, Lampsilis orbiculata (the pink mucket) and Plethobasus cooperianus (the orange-footed pimpleback), once occurred in the section of the Tennessee River referred to today as the Kentucky Dam tailwaters from Kentucky Dam at river mile 22.4 to the Ohio River at Paducah,

Kentucky.

The first documented survey of the mussels in this region of the Tennessee River was the one by M. M. Ellis in 1931 (Table 1) and reported by van der Schalie (1939). Ellis found 2 specimens of Plethobasus cooperianus in a sample of 167 mussels. This species has not been reported since then until the discovery by Sickel (1981) of shells in a commercial musseler's catch. The only report of Lampsilis orbiculata in the Kentucky Dam tailwaters was the find of a single specimen in 1978 at river mile 22.0 reported by TVA (1978). A summary of the available reports on previous mussel surveys of the Kentucky Dam tailwater section of the Tennessee River (Table 1) shows that Ellis found 20 species, Williams (1969) reported 21 species, Isom (1969) reported 22 species, Bates (1975) reported 13 species, and TVA (1978) reported 27 species. The large differences in the number of reported species is more of a reflection on sample technique and effort than an indication of changes in actual species composition. Because of the size, depth, and diversity of the lower Tennessee River, the cost of obtaining a complete species list would be prohibitive, and such an effort would be destructive to the mussel community. However, the list compiled in the present study is the most complete list produced to date--36 species.

In addition to the importance of endangered mussel species, the mussels of the Tennessee River provide a valuable resource to commercial musselers who sell shells for use in the Japanese cultured pearl industry. Also, the mussels play a major role as components of the river ecosystem, cleansing the river through their filtering activities and providing food for other benthic invertebrates which in turn support a diverse fish community. This translates into a greater overall productivity and natural balance for the river.

METHODS AND MATERIALS

The major mussel beds were located by interviewing commercial musselers, by brail samples, and by reference to earlier reports. The only available report that gave accurate locations of mussel beds in the lower Tennessee River was the Tennessee Valley Authority survey (TVA, 1978).

Qualitative sampling was conducted using a 10 ft. mussel brail with "mud" hooks (crowfoot hooks with the No. 12 gauge wire recurved to about a 45° angle from the shank). Quantitative samples used to determine species composition and density were collected by SCUBA divers. Divers used 1 m^2 quadrats which were square frames made of aluminum bar. The frames were subdivided into 9 equal squares to assist the diver in maintaining orientation under conditions of low visibility when sampling must be done by touch rather than sight. In this study the visibility was good at all sights except a few at a depth greater than 6 m. At sites where quadrats were used, the placing of the quadrat was done to obtain a representative sample of the mussel community and not to obtain the highest density.

In representative samples at each site, mussels were measured for shell length to the nearest mm and total live weight to the nearest g. Age in years was estimated by counting prominent concentric lines believed to represent the winter rest periods. This was difficult on shells beyond 15 years old.

In mussel beds that appeared favorable for endangered species, additional efforts were expended by divers in searching beds for rare and endangered forms. This was accomplished by laying a 50 m weighted line and searching the length of the line and 1 m to either side so that each search would cover approximately 100 m^2.

At each sample location the distance from the left or right shore (facing downstream) was measured using a Ranging Inc. model 1200 Rangematic-MK5 range finder which has a reported accuracy of 95%. The river elevation during the study was between 301-303 feet above mean sea level with the discharge from Kentucky Dam being generally between 8,000 and 40,000 cfs.

RESULTS AND DISCUSSION

From June 16 through August 22, 1985, brail and SCUBA sampling were conducted in the Kentucky Dam tailwaters of the Tennessee River from the Ohio River to Kentucky Dam at Tennessee River mile (TRM) 22.4. Brailing was used at 32 sites in the river from TRM 7.5 to 21.8 and diving was used at 20 sites from TRM 10.0 to 22.0. Mussels totaling 4,384 individuals (not counting 909 Asiatic clams) were collected, identified, measured and returned to the river except for voucher specimens placed in the Murray State University Mollusk Museum of all but the endangered species.

Living specimens of 34 species were collected, and fresh shells of two additional species were found, Lampsilis teres and Obovaria olivaria (Table 1). It is likely that these two species still survive in the river but they are extremely rare. A list of all the species ever reported alive from this section of the Tennessee River with their common names is given in Table 2. It should be pointed out that these names are used here because they are the names that have been in common use for over a century. However, continuing revision of the nomenclature warrants the inclusion of earlier names considered to be synonyms for a number of the species. Some of these names are appearing in the literature with greater frequency. These synonyms were listed by Morrison

(1969): Megalonaias nervosa (Rafinesque, 1820) = Megalonaias gigantea (Barnes, 1823); Plethobasus striatus (Rafinesque, 1820) = Plethobasus cooperianus (Lea, 1834); Cyprogenia stegaria (Rafinesque, 1820) = Cyprogenia irrorata (Lea, 1830); Lampsilis abruptus (Say, 1831) = Lampsilis orbiculata (Hildreth, 1828).

Species Composition of Sample Sites

The 51 sample sites are shown on the maps in Figures 1-5. Sample sites were selected after reviewing previous reports, interviewing commercial musselers and fishermen, examining the shoreline for relic shells, and reconnaissance sampling with a brail. Sites were more extensively sampled by brailing and SCUBA diving if they appeared to have a significant mussel community considered to be a "bed." Mussel beds generally occur in stable substrate, usually gravel and sand in compact silt and clay. Beds are composed of mussels of various age classes and species in significant densities, generally greater than $1/m^2$. A viable bed must exhibit clear signs of reproduction and recruitment. The establishment of a bed requires many years since mussel recruitment is generally a slow process. It is not uncommon to find beds composed of individuals ranging from 5-25 years in age and very few juveniles (Sickel, 1982).

Some commercial musselers consider the entire tailwater region from Kentucky Dam to approximately mile 11.0 to be a mussel bed. In fact, mussels may be collected by brail throughout the river. However, there are several areas where the density of mussels is much greater than other areas, and these areas are considered mussel beds. Table 3 presents a list of all the mussels examined in the survey at each of the 51 sites. Sites with large numbers of mussels and numerous species generally indicate beds. Most of the beds were

located along the right bank in water 2-5 m deep and in gravel or sandy-gravel substrates.

The most extensive beds were located between miles 20.5-21.5 from 10-80 m out from the right bank and between miles 18.0-17.6 about 10-60 m out from the right bank. From mile 12 to mile 15 mussels were distributed throughout the bottom from bank to bank with older individuals along the right bank, particularly Pleurobema cordatum at TRM 14.75 and Megalonaias gigantea at TRM 13.5. Many young Fusconaia ebena occurred near the left bank at TRM 14.5 below the Pennwalt and GAF outfalls. This area appeared to have few old mussels, and looked as if there may have been a mussel die-off some years ago.

Signs of good reproductive success and high recruitment with many young mussels were evident at 5 beds, Sites 5-10 (TRM 21.2-21.6-Right), Site 22 (TRM 17.8-Right), Site 27 (TRM 14.75-Right), Site 29 (TRM 14.5-Left) and Site 42 (TRM 13.5-Right). The first two areas, Sites 5-10 and Site 22 had the highest recruitment of young. Both areas were sandy gravel, and it was in the patches of sand that the highest density of young mussels was found.

Sites 5-10 are of particular interest because commercial musselers have expressed the concern that within the mussel sanctuary, TRM 17.8-22.4, only old mussels occur, and that because of the high density no recruitment can occur. What was seen in this study indicates to the contrary that excellent reproduction and recruitment is occurring in the sanctuary, and that this most likely provides juveniles for beds downstream--particularly in areas where commercial musseling has thinned the community to the level where reproduction may be reduced.

Mussel Densities

Where mussels were sampled by divers using square meter quadrats, the

densities ranged from 12 to 153 individuals per m^2 (Table 4). These sites were selected to be representative of the beds and probably represent a higher than mean value for density but are definitely lower than some of the maximum density areas. Earlier studies that reported densities (Isom, 1969) used grab sampling to sample the mussels. This method is inadequate in most areas of the river because of the gravel and rock substrate and the mussels themselves that prevent a grab from digging in properly and getting a quantitative sample. Also, mussels were found to a depth of 30 cm in the sediment. These mussels would be missed by all sampling methods used by previous investigators. In many areas, a diver sampling within a meter square frame would dig out a mussel and find another almost directly below it. At site 4, particularly, mussels were 2 and 3 deep in the sediment. This site was unusual in being located at the bottom of a riprap wall near the lock entrance. The highest density of mussels, $153/m^2$ (Table 4), occurred within 2 m of the wall. Beyond that distance the numbers decreased sharply. These were mostly old, badly eroded mussels of little commercial value, and very few young occurred there.

The next highest density occurred at site 7. Here the high density was attributed to the sandy sediments that supported many young individuals. The sand apparently came from Russell Creek at mile 21.7. Another bed with exceptionally high density was at mile 17.8, Site 22. Although the average density for this site given in Table 4 was $35/m^2$, one sample had $74/m^2$ near shore in a sandy area and most of the individuals were young (Fig. 6 Fusconaia ebena length distribution at Site 22). This was another site within the sanctuary where recruitment was high.

The lowest density sampled with quadrats by divers was at Site 40. The density was 12 mussels/m^2. A diver casually skimming the sediment surface would find few mussels here. But when a meter square frame is placed on the

sediment and the diver carefully excavates the sediment, a surprising number of mussels may be found.

Lower densities were observed in the channel out from Site 45, but these areas were not sampled quantitatively. These areas were being brailed extensively by commercial musselers.

Comparative Percent Composition

The percent composition of all mussel species collected live in this survey is shown in Table 5 along with data from other studies. The similarities in percent composition between the different studies going back to Ellis' 1931 collection (van der Schalie, 1939) are striking considering the changes brought about by the construction of Kentucky Dam. Probably, many of the minor differences seen between the various studies result from differences in intensity of sampling in different habitats where species composition varies and differences in sampling techniques. Major differences worth pointing out are the declines in Quadrula metanevra, Quadrula nodulata, Plethobasus cooperianus, Pleurobema cordatum, and Obovaria olivaria, and the increase in dominance of Quadrula pustulosa, Amblema plicata, Fusconaia ebena, Cyclonaias tuberculata, and Plagiola lineolata. It is difficult to make any other comparisons because of the differences in how the data were collected by the different investigators. However, the presence of 36 species reported in this study indicates that the Kentucky Dam tailwaters still support a healthy and diverse mussel fauna and that present water quality is suitable for continued mussel survival.

There is no consensus on a definition of a rare species, but, if we consider an occurrence of less than 1 per 1000 individuals as being rare, then 10 mussels belong in that category (Table 5). These along with their percent

occurrence are Plethobasus cooperianus (0.07), Plethobasus cyphyus (0.07), Anodonta imbecillis (0.05), Ptychobranchus fasciolaris (0.05), Actinonaias carinata (0.02), Obovaria olivaria (0.01), Obovaria retusa (0.02), Lampsilis teres (0.02), Lampsilis orbiculata (0.05), and Lampsilis ovata (0.09). Since there was no evidence of recruitment in any of these species, it is assumed that they are either the remnants of former populations or they are random introductions from populations outside of the Kentucky Dam tailwater area.

Age and Growth

Because Fusconaia ebena was the most abundant mussel at nearly every site, and because the numbers collected were sufficient for statistical tests, it was used to study growth relationships of mussels and to compare these relationships between different sites. Figure 7 shows the age frequency and the shell length frequency distributions of F. ebena at Sites 20, 26, 27, 29, and 40. Site 20 at TRM 18.0 had the most uniform distribution of age and appears to be a stable population with sufficient recruitment to maintain the more uniform age distribution. This site is just inside the mussel sanctuary. Sites 26-40 (Fig. 7) display age distributions skewed toward the younger individuals. This suggests that environmental conditions existed from 8-10 years ago that prevented recruitment or survival of young. These sites are in the vicinity of the industrial outfalls at mile 15.0.

An analysis comparing length and age relationships for the five sites in Fig. 7 indicated that mussels at Site 26 had the slowest growth rate and grew at a significantly slower rate than at Sites 20, 27, and 29 but not significantly slower than at Site 40. The growth rate at Site 40 was less than at Sites 20, 27 and 29 but the difference was not significant at the .05 level. Growth rate, measured as shell length at a given age, varies depending on

habitat characteristics, and it cannot be stated here with certainty that the reduced growth rate at Site 26 resulted from a negative influence of the industrial outfalls. Perhaps a chemical analysis of mussels from different sites would reveal some factor causing the reduced growth rate. A red, powdery deposit was seen on shells from Site 26 that was not seen on shells from other sites, but the composition of this substance has not been determined.

The age distribution in a population indicates whether recent recruitment has occurred. For this study, sites were grouped to represent mussel beds in specific areas of the river. Tables 6-10 show the age frequency distribution of all mussels from the designated beds which included the sites indicated on the tables. Since it is difficult in many cases to determine age in mussels over 12-15 years old, the age data were grouped in years from 1-12 and greater than 12 years.

The presence of young mussels 2 years or younger in a population was used as evidence of successful reproduction and recruitment. However, small mussels of that age are selected against to some degree by brail sampling. All data represented in Tables 6-10 include diver samples except Table 8. Therefore, the reduced recruitment indicated in Table 8 may not be as accurate a reflection of the sites represented there as occurs in the other tables.

The bed between TRM 20.5-21.6 (Table 6) had the highest diversity in terms of number of species with 24 species. Evidence for recent recruitment, mussels 2 years old or less, occurred for 9 species: Quadrula nodulata, Quadrula pustulosa, Amblema plicata, Fusconaia ebena, Elliptio crassidens, Obliquaria reflexa, Truncilla truncata, Truncilla donaciformis, and Leptodea fragilis.

The bed between TRM 17.6-18.2 (Table 7) had 21 species with some recruitment seen in Tritogonia verrucosa, Quadrula cylindrica, Quadrula

metanevra, Quadrula pustulosa, Fusconaia ebena, Plagiola lineolata, and Truncilla donaciformis. Probably more young would be found if more extensive excavation sampling were conducted.

At the sites between TRM 14.5-15.0 to the left of the channel (Table 8), 14 species were found. Many young Fusconaia ebena occurred there but little other recruitment was evident. This area appeared to be disturbed, perhaps by the effluents from industrial discharges that were seen entering the river.

Fifteen species were found in the area between TRM 13.9-14.7 (Table 9). Recruitment was evident for Fusconaia ebena, Quadrula pustulosa, Truncilla truncata, and Truncilla donaciformis. The lower region of this area was being brailed extensively by commercial musselers. However, upstream from TRM 14.7, the location where Lampsilis orbiculata was found, was rocky and commercial musselers avoided it. Perhaps that is why L. orbiculata still survives there. Of additional interest is the large number of old Megalonaias gigantea with none under 12 years old. In fact, few young M. gigantea were found in any of the areas even though it constituted 4.13% of all the mussels collected.

At the bed from TRM 13.5-13.8 to the right of the channel just below Lee Creek (Sites 38, 40, 41, 42), (Table 10), it appears that good recruitment was occurring for Quadrula pustulosa, Fusconaia ebena, Truncilla truncata, Truncilla donaciformis, and Obliquaria reflexa. Other species show irregular recruitment. One of the few young Pleurobema cordatum occurred here, a 4 year old individual, but the other P. cordatum were all over 9 years old indicating poor recruitment. This was the case throughout the river for Pleurobema cordatum.

One aspect of age distribution in mussel beds that has puzzled many investigators is the apparent lack of young mussels in sufficient numbers to

perpetuate the mussel population. This is evident in Fig. 7 in which is demonstrated the paucity of 1 and 2 year old mussels. Since, obviously, the populations are perpetuated and many mussels appear after they reach 3 or 4 years of age, either there must be a refuge for the young mussels in some location other than the bed, or they are located in the bed in such a manner as to be missed by the standard sampling techniques. Observations made during this study indicate both of the above may be true in varying degrees. Divers found the highest densities of young mussels in sandy areas isolated from the main beds either by being near shore or in eddies behind logs or rocks. Both areas are difficult to sample by brail. Also, the 0-2 year old mussels are seldom caught on brails because of the hook size except for occasional juveniles caught by their byssal threads. Fig. 6 indicates the large number of young mussels found by a diver in a sandy area at Site 22. It is assumed that as the mussels grow in size they move out into the more stable gravel substrates.

Diver collected samples generally produced more young mussels than did brail samples. Also, samples collected by a diver using a m^2 quadrat generally had more young mussels than samples collected by divers covering a large area. This is because the diver using the quadrat would excavate the sediments within the quadrat to a depth of 20-30 cm. It was observed that young mussels were commonly buried that deep in sandy-gravel sediments. This being the case, standard methods of sampling using brail, grabs, or divers skimming the sediment surface would miss most of the juvenile mussels. Commercial mussel divers have indicated that they find live mussels as deep in the sediments as they can dig, up to an arm's length. This aspect of mussel ecology needs to be examined in detail particularly since the sediments serve as traps for many pollutants, and, if the deeper sediments become contaminated, then the primary

habitat for young mussels may be permanently destroyed.

Asiatic Clams in Samples

The Asiatic clam, Corbicula fluminea, occurred in many of the samples but was abundant at only two sites. This is in contrast to the study by Williams (1969) which reported Corbicula to be the most abundant bivalve in the river. Only 909 Corbicula were found in the present study and 743 of these came from Site 39 at TRM 13.8. This site was predominantly Corbicula, and they covered the bottom several individuals thick at a density of over $1000/m^2$. The bottom literally moved continuously as clams jockeyed for position. Many dead clams were seen, and numerous dead bodies were seen floating downstream from this site. The death of these clams in an overpopulated condition results in what has commonly been reported as a clam die-off. This site appeared to have been disturbed either by toxic discharge, overharvest by musselers, or by dredging of the channel at Bailey Grain terminal just upstream. Whatever the cause of the disturbance, the mussels have been reduced allowing Corbicula to invade and proliferate. Corbicula seems to be under the influence of natural controls in other areas of the river where mussels are undisturbed.

Gastropods

Snails were common in most samples from the dam to river mile 13.8. The following species were found: Viviparus georgianus (Lea, 1834), only at TRM 14.0; Lithasia armigera (Say, 1821) was abundant from TRM 14.5-22.0; Lithasia verrucosa (Rafinesque, 1820) was abundant from TRM 14.5-22.0; Lithasia verrucosa lima (Conrad, 1834) only at TRM 17.8; Pleurocera canaliculatum canaliculatum (Say, 1821) at TRM 14.0; Pleurocera canaliculatum excuratum (Conrad, 1834) was abundant from TRM 13.5-22.0; and

Campeloma ponderosum (Say, 1821) occurred at TRM 17.8.

Branson et al. (1981) listed Lithasia armigera and Lithasia verrucosa as endangered in Kentucky and candidates for listing on the federal endangered species list.

Endangered Species of Mussels in the Kentucky Dam Tailwater

Of the 36 species found in this study, two are on the federal endangered species list, Plethobasus cooperianus (the orange-footed pimpleback) and Lampsilis orbiculata (the pink mucket). Three specimens of P. cooperianus were found in the extensive bed at mile 20.7. The individuals were over 12 years old and were not gravid. The substrate of the bed was a coarse gravel in a stable sand-silt-clay material. No young were found, and it is presumed that either no reproduction was occurring because male and female mussels were too widely separated or because the appropriate fish host for the larvae was absent. This find of P. cooperianus in this section of the Tennesee River is the first report since the 1931 report be Ellis (van der Schalie, 1939). To protect the remaining P. cooperianus , the prohibition of commercial musseling in this area should be continued.

The other endangered species found in this study was Lampsilis orbiculata. (the pink mucket). Only one individual of this species had ever been reported from the Kentucky Dam tailwaters, and that was by TVA (1978). That specimen was found just below the dam at mile 22.0. In the present study, two specimens were found at mile 14.75. One of the specimens was a gravid female determined so by the swollen marsupium visible through the gap at the siphons. The substrate at this site was sandy gravel with several large rocks and exposed bedrock. Mussel brails hang on the rocks so commercial musselers were avoiding this site. The gravid female indicated that potential

reproduction was occurring, however no young were found. This might suggest the lack of a suitable fish host.

Further studies on these two endangered species are needed and a recovery program should be initiated. The Kentucky Dam tailwater has the potential for being a major recovery area for these rare mussels.

CONCLUSIONS

The Kentucky Dam tailwater section of the Tennessee River, miles 0-22.4, supports a diverse mussel fauna of at least 36 species. However, 10 of these species are rare with an abundance of less than 1 per 1000 individuals and with no apparent recruitment. Two of these are on the federal endangered species list, Lampsilis orbiculata (the pink mucket) and Plethobasus cooperianus (the orange-footed pimpleback). Additional studies are needed to determine if it would be feasible to institute a recovery program for these two species in the Kentucky Dam tailwaters.

The most diverse and densest beds occur within the mussel sanctuary, TRM 17.8-22.4. Good recruitment of most species is occurring in these beds and it is recommended that they continue to be protected from commercial musseling and from other activities such as dredging or construction projects that may disturb these beds.

Growth rates of Fusconaia ebena were greater in those beds located upstream from the industrial outfalls at TRM 15.0. The area downstream from these outfalls along the left bank to TRM 13.8 appeared disturbed. This was reflected in the high density of Corbicula at mile 13.8.

The following recommendations are made to protect the mussels in the

Kentucky Dam tailwater area of the Tennessee River: (1) Prevent further deterioration of environmental conditions; (2) Strive for continued improvement in water quality as improvements become feasible; (3) Initiate an endangered species recovery program; (4) Maintain and protect the mussel sanctuary, TRM 17.8-22.4, from commercial musseling or other activities that might disturb the mussel beds.

Table 1. Mussels reported in Kentucky Dam tailwater surveys.

Species	Ellis 1931	Williams 1969	Isom 1969	Bates 1975	TVA 1978	Sickel 1985
1. Megalonaias gigantea	x	x	x	x	x	x
2. Tritogonia verrucosa	-	x	x	-	x	x
3. Quadrula quadrula	x	x	x	x	x	x
4. Quadrula apiculata aspera	-	-	-	-	-	x
5. Quadrula cylindrica	-	x	x	-	x	x
6. Quadrula metanevra	x	x	x	x	x	x
7. Quadrula nodulata	x	x	-	-	x	x
8. Quadrula pustulosa	x	x	x	x	x	x
9. Amblema plicata	x	x	x	x	x	x
10. Fusconaia ebena	x	x	x	x	x	x
11. Fusconaia subrotunda	x	-	x	-	x	x
12. Fusconaia flava undata	x	-	x	-	x	x
13. Cyclonaias tuberculata	x	x	x	x	x	x
14. Plethobasus cyphyus	-	x	-	-	x	x
15. Plethobasus cooperianus *	x	-	-	-	-	x
16. Pleurobema cordatum	x	x	x	x	x	x
17. P. cordatum pyramidatum	x	-	x	-	-	-
18. Elliptio crassidens	x	x	x	-	x	x
19. Elliptio dilatata	x	x	x	x	x	x
20. Anodonta imbecillis	-	x	-	-	-	x
21. Anodonta grandis	-	-	-	-	-	x
22. Arcidens confragosus	-	-	-	-	x	x
23. Lasmigona complanata	-	-	-	-	x	x
24. Ptychobranchus fasciolaris	-	x	-	-	-	x
25. Obliquaria reflexa	x	x	x	x	x	x
26. Cyprogenia irrorata	-	-	x	-	x	-
27. Actinonaias carinata	-	-	-	-	-	x
28. Plagiola lineolata	-	x	x	x	x	x
29. Obovaria olivaria	x	-	-	-	-	s
30. Obovaria retusa	-	-	-	-	-	x
31. Truncilla truncata	x	-	-	-	x	x
32. Truncilla donaciformis	x	-	x	x	x	x
33. Leptodea fragilis	-	-	-	-	x	x
34. Proptera alata	-	x	x	x	x	x
35. Ligumia recta	-	x	x	-	x	x
36. Lampsilis teres	x	-	x	-	-	s
37. Lampsilis orbiculata *	-	-	-	-	x	x
38. Lampsilis ovata	-	x	-	-	-	x
Total Number of Species	20	21	22	13	27	36

x = present, - = absent, s = only fresh shells were found
*On Federal Endangered Species List

Table 2. Scientific and common names of freshwater mussels reported since 1931 from the Kentucky Dam tailwater section of the Tennessee River.

Species	Common Name
1. Megalonaias gigantea (Barnes, 1823)	Washboard
2. Tritogonia verrucosa (Rafinesque, 1820)	Buckhorn or pistolgrip
3. Quadrula quadrula (Rafinesque, 1820)	Mapleleaf
4. Quadrula apiculata aspera (Lea, 1831)	Tubercled mapleleaf
5. Quadrula cylindrica (Say, 1817)	Rabbit foot
6. Quadrula metanevra (Rafinesque, 1820)	Monkeyface
7. Quadrula nodulata (Rafinesque, 1820)	Wartyback
8. Quadrula pustulosa (Lea, 1831)	White pimpleback
9. Amblema plicata (Say, 1817)	Three ridge
10. Fusconaia ebena (Lea, 1831)	Ebony shell
11. Fusconaia subrotunda (Lea, 1831)	Long solid
12. Fusconaia flava undata (Barnes, 1823)	Pigtoe or Wabash pigtoe
13. Cyclonaias tuberculata (Rafinesque, 1820)	Purple pimpleback
14. Plethobasus cyphyus (Rafinesque, 1820)	Bullhead
15. Plethobasus cooperianus (Lea, 1834)	Orange-footed pimpleback
16. Pleurobema cordatum (Rafinesque, 1820)	Ohio pigtoe
17. Pleurobema cordatum f. pyramidatum (Lea, 1834)	Pigtoe or pink pigtoe
18. Elliptio crassidens (Lamarck, 1819)	Elephant ear
19. Elliptio dilatata (Rafinesque, 1820)	Spike or ladyfinger
20. Anodonta imbecillis (Say, 1829)	Papershell
21. Anodonta grandis (Say, 1829)	Giant floater
22. Arcidens confragosus (Say, 1829)	Rock pocketbook
23. Lasmigona complanata (Barnes, 1823)	White heelsplitter
24. Ptychobranchus fasciolaris (Rafinesque, 1820)	Kidney shell
25. Obliquaria reflexa Rafinesque, 1820	Three-horned wartyback
26. Cyprogenia irrorata (Lea, 1829)	Fan shell
27. Actinonaias carinata (Barnes, 1823)	Mucket
28. Plagiola lineolata (Rafinesque, 1820)	Butterfly
29. Obovaria olivaria (Rafinesque, 1820)	Hickory nut or eggshell
30. Obovaria retusa (Larmarck, 1819)	Ring pink or golfstick
31. Truncilla truncata Rafinesque, 1820	Deertoe
32. Truncilla donaciformis (Lea, 1827)	Fawnfoot
33. Leptodea fragilis (Rafinesque, 1820)	Fragile papershell
34. Proptera alata (Say, 1817)	Pink heelsplitter
35. Ligumia recta (Lamarck, 1819)	Black sandshell
36. Lampsilis teres (Rafinesque, 1820)	Yellow sandshell
37. Lampsilis orbiculata (Hildreth, 1828)	Pink mucket
38. Lampsilis ovata (Say, 1817)	Pocketbook

Table 3. Mussel species and number of each species collected at each site in the Kentucky Dam tailwaters, Tennessee River, from June 16 - August 22, 1985.

Species	Site Number 1	2	3	4	5	6	7	8
River Mile	22.0	21.8	22.0	21.8	21.6	21.5	21.5	21.4
1. Megalonaias gigantea	1	-	-	1	3	-	10	-
2. Tritogonia verrucosa	3	1	-	-	2	-	2	-
3. Quadrula quadrula	5	4	-	6	12	1	3	-
4. Quadrula apiculata aspera	-	-	-	-	2	-	2	-
5. Quadrula cylindrica	-	-	-	-	-	-	-	-
6. Quadrula metanevra	-	-	-	-	1	-	1	-
7. Quadrula nodulata	3	-	-	-	3	-	1	-
8. Quadrula pustulosa	-	1	-	1	36	-	24	2
9. Amblema plicata	3	9	-	23	71	2	21	1
10. Fusconaia ebena	-	-	2	18	90	4	66	1
11. Fusconaia subrotunda	-	-	-	-	-	-	1	-
12. Fusconaia flava undata	-	-	-	-	-	-	-	-
13. Cyclonaias tuberculata	-	-	-	1	21	1	1	1
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-
16. Pleurobema cordatum	-	-	-	3	5	-	2	-
17. Elliptio crassidens	-	-	5	2	7	-	1	-
18. Elliptio dilatata	-	1	1	3	5	1	1	1
19. Anodonta imbecillis	-	-	-	-	-	-	-	-
20. Anodonta grandis	-	-	-	1	-	-	-	-
21. Arcidens confragosus	-	-	-	1	-	-	-	-
22. Lasmigona complanata	1	-	-	-	1	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-
24. Obliquaria reflexa	1	-	-	-	10	-	5	1
25. Actinonaias carinata	-	-	-	-	-	-	-	-
26. Plagiola lineolata	1	-	-	1	13	1	1	-
27. Obovaria olivaria	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-
29. Truncilla truncata	-	-	-	-	3	-	1	-
30. Truncilla donaciformis	-	-	-	-	1	-	3	-
31. Leptodea fragilis	6	-	-	3	4	-	2	-
32. Proptera alata	-	2	-	-	4	-	1	-
33. Ligumia recta	-	-	-	-	4	-	1	-
34. Lampsilis teres	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-
Total Number of Mussels	24	18	8	64	298	10	150	7
Total Number of Species	9	6	3	13	21	6	21	6

Table 3. (Continued)

	Site Number							
	9	10	11	12	13	14	15	16
River Mile	21.3	21.2	21.2	21.0	20.7	20.6	20.5	20.5
Species								
1. Megalonaias gigantea	15	1	2	2	2	6	16	-
2. Tritogonia verrucosa	-	2	1	-	1	-	-	-
3. Quadrula quadrula	7	5	2	1	2	1	4	-
4. Quadrula apiculata aspera	-	-	-	1	1	-	-	-
5. Quadrula cylindrica	-	-	-	-	-	-	-	-
6. Quadrula metanevra	-	1	-	-	1	-	2	1
7. Quadrula nodulata	-	-	1	-	-	-	-	1
8. Quadrula pustulosa	7	22	13	2	2	4	10	16
9. Amblema plicata	50	17	5	3	5	9	24	22
10. Fusconaia ebena	19	41	5	2	17	11	8	96
11. Fusconaia subrotunda	8	1	-	-	-	-	4	-
12. Fusconaia flava undata	-	-	-	-	-	-	-	-
13. Cyclonaias tuberculata	6	3	4	3	1	2	17	4
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	2	1	-	-
16. Pleurobema cordatum	5	8	1	1	2	7	16	1
17. Elliptio crassidens	6	5	2	-	1	-	7	2
18. Elliptio dilatata	3	2	1	1	1	3	8	4
19. Anodonta imbecillis	-	-	-	-	-	-	-	-
20. Anodonta grandis	1	-	-	-	-	-	-	-
21. Arcidens confragosus	-	-	-	-	-	-	-	-
22. Lasmigona complanata	-	-	-	-	-	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-
24. Obliquaria reflexa	3	5	4	-	1	1	2	7
25. Actinonaias carinata	-	-	-	-	1	-	-	-
26. Plagiola lineolata	12	9	4	3	1	9	14	3
27. Obovaria olivaria	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-
29. Truncilla truncata	-	1	-	-	-	-	-	1
30. Truncilla donaciformis	1	5	-	-	2	-	-	1
31. Leptodea fragilis	-	1	-	-	-	-	-	1
32. Proptera alata	1	2	1	-	1	1	1	-
33. Ligumia recta	-	1	-	-	-	-	3	-
34. Lampsilis teres	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-
Total Number of Mussels	144	132	46	19	44	55	136	160
Total Number of Species	15	19	14	10	18	12	15	14

Table 3. (Continued)

	Site Number							
	17	18	19	20	21	22	23	24
River Mile	19.2	18.7	18.2	18.0	17.8	17.8	17.7	17.6
Species								
1. Megalonaias gigantea	-	-	-	13	1	4	6	1
2. Tritogonia verrucosa	-	-	1	2	1	-	-	-
3. Quadrula quadrula	1	2	1	20	6	17	6	-
4. Quadrula apiculata aspera	-	-	-	-	-	1	-	-
5. Quadrula cylindrica	-	-	-	1	4	11	-	-
6. Quadrula metanevra	-	-	-	6	3	2	-	2
7. Quadrula nodulata	-	-	-	3	-	-	1	-
8. Quadrula pustulosa	-	1	1	20	7	133	16	1
9. Amblema plicata	11	4	1	26	6	76	4	3
10. Fusconaia ebena	-	2	-	19	23	476	17	16
11. Fusconaia subrotunda	-	-	-	-	-	3	-	-
12. Fusconaia flava undata	-	-	-	1	-	-	-	-
13. Cyclonaias tuberculata	-	-	1	13	13	64	4	3
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-
16. Pleurobema cordatum	-	-	-	32	1	38	1	-
17. Elliptio crassidens	-	-	-	3	-	4	-	-
18. Elliptio dilatata	-	-	-	10	-	8	1	-
19. Anodonta imbecillis	-	-	-	-	-	-	-	-
20. Anodonta grandis	-	-	-	-	-	-	-	-
21. Arcidens confragosus	-	-	-	-	-	-	1	-
22. Lasmigona complanata	-	-	-	1	-	1	-	-
23. Ptychobranchus fasciolaris	-	-	-	1s	-	-	-	-
24. Obliquaria reflexa	-	-	-	8	2	37	3	6
25. Actinonaias carinata	-	-	-	-	-	-	-	-
26. Plagiola lineolata	-	-	1	17	6	38	2	1
27. Obovaria olivaria	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-
29. Truncilla truncata	-	-	-	-	-	12	-	-
30. Truncilla donaciformis	-	1	-	-	-	21	-	-
31. Leptodea fragilis	-	-	-	-	-	9	-	-
32. Proptera alata	-	1	-	4	-	5	-	-
33. Ligumia recta	-	-	-	-	-	1	-	-
34. Lampsilis teres	-	-	-	-	-	-	1s	-
35. Lampsilis orbiculata	-	-	-	-	-	1/2s	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	4
Total Number of Mussels	12	11	6	200	73	961.5	63	37
Total Number of Species	2	6	6	19	12	22	13	9

Table 3. (Continued)

	Site Number							
	25	26	27	28	29	30	31	32
River Mile	17.6	15.0	14.7	14.6	14.5	14.5	14.4	14.2
Species								
1. Megalonaias gigantea	-	-	11	-	-	3	4	2
2. Tritogonia verrucosa	-	-	2	-	1	1	-	-
3. Quadrula quadrula	5	6	7	6	1	-	-	-
4. Quadrula apiculata aspera	-	-	-	-	-	-	-	-
5. Quadrula cylindrica	-	1	-	-	-	-	-	-
6. Quadrula metanevra	2	3	4	-	1	1	-	2
7. Quadrula nodulata	4	1	-	-	-	-	-	-
8. Quadrula pustulosa	15	16	22	2	7	2	2	2
9. Amblema plicata	13	4	8	1	3	4	-	4
10. Fusconaia ebena	32	31	72	8	41	7	6	8
11. Fusconaia subrotunda	-	-	2s	-	2	2	-	-
12. Fusconaia flava undata	1	-	-	1s	-	-	-	-
13. Cyclonaias tuberculata	10	1	40	1	2	5	-	1
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-
16. Pleurobema cordatum	4	-	54	-	-	28	2	5
17. Elliptio crassidens	1	-	5	-	-	1	-	-
18. Elliptio dilatata	1	-	7	-	-	-	-	-
19. Anodonta imbecillis	-	-	-	-	-	-	-	-
20. Anodonta grandis	-	-	-	-	-	-	-	-
21. Arcidens confragosus	-	-	-	-	-	-	-	-
22. Lasmigona complanata	-	-	-	-	-	-	-	-
23. Ptychobranchus fasciolaris	1	-	-	-	-	-	-	-
24. Obliquaria reflexa	4	5	4	-	5	-	-	-
25. Actinonaias carinata	-	-	-	-	-	-	-	-
26. Plagiola lineolata	5	2	22	1	2	7	3	2
27. Obovaria olivaria	1/2s	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-
29. Truncilla truncata	1	-	3	1	-	-	-	-
30. Truncilla donaciformis	1	-	6	-	-	-	-	-
31. Leptodea fragilis	1	-	3	-	-	-	-	-
32. Proptera alata	2	-	4	-	-	1	-	1
33. Ligumia recta	-	-	1	-	-	-	-	-
34. Lampsilis teres	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	2	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-
Total Number of Mussels	103.5	70	279	21	65	62	17	27
Total Number of Species	19	10	20	8	10	12	5	9

Table 3. (Continued)

	Site Number							
	33	34	35	36	37	38	39	40
River Mile	14.2	14.1	14.0	13.9	13.8	13.8	13.8	13.6
Species								
1. Megalonaias gigantea	4	4	10	15	-	4	-	2
2. Tritogonia verrucosa	-	-	-	1	-	1	-	-
3. Quadrula quadrula	-	1	1	5	-	1	1	2
4. Quadrula apiculata aspera	-	-	-	1	-	-	-	1
5. Quadrula cylindrica	-	-	-	-	-	1	-	-
6. Quadrula metanevra	1	1	-	-	-	-	-	1
7. Quadrula nodulata	-	-	-	-	-	1	-	-
8. Quadrula pustulosa	1	3	1	5	16	5	18	13
9. Amblema plicata	4	3	6	3	2	1	13	6
10. Fusconaia ebena	18	10	14	23	22	22	70	27
11. Fusconaia subrotunda	-	-	4	1	1	-	-	6
12. Fusconaia flava undata	-	-	1	-	-	2	-	-
13. Cyclonaias tuberculata	2	4	4	7	3	10	3	3
14. Plethobasus cyphyus	-	-	2	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-
16. Pleurobema cordatum	4	-	14	26	1	13	-	16
17. Elliptio crassidens	2	-	-	3	-	1	-	1
18. Elliptio dilatata	-	-	-	1	-	3	-	3
19. Anodonta imbecillis	-	-	-	-	-	-	-	-
20. Anodonta grandis	1	-	-	-	-	-	-	-
21. Arcidens confragosus	-	-	-	1	-	-	-	-
22. Lasmigona complanata	-	-	-	1	-	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-
24. Obliquaria reflexa	1	-	-	1	2	-	7	1
25. Actinonaias carinata	-	-	-	-	-	-	-	-
26. Plagiola lineolata	-	-	4	2	1	6	1	4
27. Obovaria olivaria	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	1/2s	-
29. Truncilla truncata	2	-	-	-	-	-	3	-
30. Truncilla donaciformis	2	-	-	-	-	-	-	1
31. Leptodea fragilis	1	-	-	-	-	-	1	-
32. Proptera alata	-	1	1	3	3	3	4	3
33. Ligumia recta	-	-	-	-	-	-	-	-
34. Lampsilis teres	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-
Total Number of Mussels	43	27	62	99	51	74	121.5	90
Total Number of Species	13	8	12	17	9	15	11	16

Table 3. (Continued)

	Site Number							
	41	42	43	44	45	46	47	48
River Mile	13.5	13.5	12.5	12.5	12.0	11.8	11.3	10.5
Species								
1. Megalonaias gigantea	14	6	1	-	1	-	16	-
2. Tritogonia verrucosa	-	1	-	-	-	-	-	-
3. Quadrula quadrula	12	7	-	-	1	1	1	-
4. Quadrula apiculata aspera	-	-	-	-	-	-	-	-
5. Quadrula cylindrica	1	-	-	-	-	-	-	1
6. Quadrula metanevra	-	1	-	-	6	-	-	-
7. Quadrula nodulata	1	1	-	-	-	-	-	-
8. Quadrula pustulosa	4	22	6	-	4	-	1	-
9. Amblema plicata	5	14	5	-	15	-	-	-
10. Fusconaia ebena	13	78	3	-	55	1	4	-
11. Fusconaia subrotunda	2	-	-	-	-	-	-	-
12. Fusconaia flava undata	-	-	1	1	-	-	-	-
13. Cyclonaias tuberculata	2	2	1	-	-	-	-	-
14. Plethobasus cyphyus	1	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	1/2s	-	-	-	-	-	-
16. Pleurobema cordatum	6	2	9	2	-	-	2	-
17. Elliptio crassidens	-	1	-	-	-	-	2	-
18. Elliptio dilatata	2	2	-	-	-	-	-	-
19. Anodonta imbecillis	-	1	-	-	1	-	-	-
20. Anodonta grandis	-	-	-	-	-	-	1	-
21. Arcidens confragosus	-	1	-	-	1	-	-	-
22. Lasmigona complanata	-	-	-	-	-	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-
24. Obliquaria reflexa	1	9	-	-	1	1	-	-
25. Actinonaias carinata	-	-	-	-	-	-	-	-
26. Plagiola lineolata	3	6	1	-	2	-	-	-
27. Obovaria olivaria	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	1	-	-	-	-
29. Truncilla truncata	-	8	-	-	3	-	-	-
30. Truncilla donaciformis	-	9	-	-	3	-	-	-
31. Leptodea fragilis	-	-	-	-	-	-	2	-
32. Proptera alata	4	1	2	-	-	-	6	1
33. Ligumia recta	-	-	-	-	-	-	-	-
34. Lampsilis teres	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-
Total Number of Mussels	71	172.5	29	4	93	3	35	2
Total Number of Species	15	20	9	3	12	3	9	2

Table 3. (Continued)

Species	Site Number 49 River Mile 10.0	50 8.5	51 7.5	TOTAL	PERCENT COMPOSITION
1. Megalonaias gigantea	-	-	-	181	4.1
2. Tritogonia verrucosa	-	-	-	23	0.52
3. Quadrula quadrula	3	-	-	167	3.8
4. Quadrula apiculata aspera	-	-	-	9	0.21
5. Quadrula cylindrica	-	-	-	20	0.46
6. Quadrula metanevra	-	1	-	44	1.0
7. Quadrula nodulata	-	-	-	21	0.48
8. Quadrula pustulosa	2	3	-	491	11.2
9. Amblema plicata	5	1	1	517	11.8
10. Fusconaia ebena	33	17	-	1548	35.3
11. Fusconaia subrotunda	-	-	-	37	0.84
12. Fusconaia flava undata	-	-	1	9	0.21
13. Cyclonaias tuberculata	1	-	-	265	6.04
14. Plethobasus cyphyus	-	-	-	3	0.07
15. Plethobasus cooperianus	-	-	-	3+1/2s	0.07
16. Pleurobema cordatum	-	-	-	311	7.1
17. Elliptio crassidens	-	-	-	62	1.4
18. Elliptio dilatata	-	-	-	74	1.7
19. Anodonta imbecillis	-	-	-	2	0.05
20. Anodonta grandis	1	-	-	5	0.11
21. Arcidens confragosus	-	-	-	5	0.11
22. Lasmigona complanata	-	-	-	5	0.11
23. Ptychobranchus fasciolaris	-	-	-	1+1s	0.05
24. Obliquaria reflexa	2	-	-	140	3.2
25. Actinonaias carinata	-	-	-	1	0.02
26. Plagiola lineolata	2	-	-	213	4.9
27. Obovaria olivaria	-	-	-	1/2s	0.01
28. Obovaria retusa	-	-	-	1+1/2s	0.02
29. Truncilla truncata	6	-	-	45	1.0
30. Truncilla donaciformis	2	-	-	59	1.3
31. Leptodea fragilis	1	-	-	35	0.8
32. Proptera alata	1	1	-	66	1.5
33. Ligumia recta	-	-	-	11	0.25
34. Lampsilis teres	-	-	-	1s	0.02
35. Lampsilis orbiculata	-	-	-	2+1/2s	0.05
36. Lampsilis ovata	-	-	-	4	0.09
Total Number of Mussels	59	23	2	4384	
Total Number of Species	12	5	2	36	

Table 4. Mussel density in number/m^2 from m^2 quadrat samples in the Kentucky Dam tailwater, Tennessee River, Kentucky.

	Site Number											
	4	7	13	16	22	27	33	39	40	42	45	49
River Mile	21.8	21.5	20.6	20.5	17.8	14.7	14.2	13.8	13.6	13.5	12.0	10.0
Species												
Megalonaias gigantea	-	10	-	-	-	0.7	3	-	-	1.0	-	-
Tritogonia verrucosa	-	2	1	-	-	-	-	-	-	-	-	-
Quadrula quadrula	15	3	-	0.7	0.75	0.3	-	-	-	1.2	-	0.5
Q. apiculata aspera	-	2	-	-	-	-	-	-	-	-	-	-
Quadrula cylindrica	-	-	-	-	0.05	-	-	-	-	-	-	-
Quadrula metanevra	-	-	-	0.3	-	-	-	-	-	-	0.5	-
Quadrula nodulata	-	1	-	0.3	-	-	-	-	-	0.2	-	-
Quadrula pustulosa	-	24	2	5.3	4.0	1.3	1	1.5	1.0	3.7	1.5	0.5
Amblema plicata	69	21	5	7.3	2.7	0.7	2	3.1	1.0	2.3	3.0	2.0
Fusconaia ebena	54	66	17	32.0	21.1	10.3	13	4.5	9.0	13.0	9.5	14.0
Cyclonaias tuberculata	-	-	1	1.3	1.5	0.7	-	-	-	-	-	0.5
Pleurobema cordatum	6	2	2	0.3	0.2	2.7	-	-	1.0	0.3	-	-
Elliptio crassidens	3	1	-	0.7	0.05	-	-	-	-	-	-	-
Elliptio dilatata	-	1	1	1.3	0.4	0.7	-	-	-	-	-	-
Obliquaria reflexa	-	5	1	2.3	1.5	-	-	3.0	-	1.5	0.5	-
Plagiola lineolata	-	1	1	1.0	1.3	1.3	-	-	-	1.0	-	1.0
Truncilla truncata	-	1	-	0.3	0.6	0.3	2	-	-	1.3	0.5	2.5
Truncilla donaciformis	-	3	2	0.3	1.0	0.7	1	-	-	1.5	0.5	0.5
Leptodea fragilis	6	2	-	0.3	-	0.3	-	-	-	-	-	-
Proptera alata	-	-	-	-	0.05	-	-	-	-	0.2	-	-
Total Density No./m	153	145	33	54	35.0	20.0	22	12.1	12.0	27.2	16.0	21.5

Table 5. Percent composition of mussel species found in surveys of the Kentucky Dam tailwater area of the Tennessee River.

Species	Ellis* 1931	Williams 1969	Isom 1969	Bates 1975	TVA 1978	Sickel 1985
1. Megalonaias gigantea	8.98	6.20	4.37	3.0	3.89	4.13
2. Tritogonia verrucosa	-	0.85	**	-	0.09	0.52
3. Quadrula quadrula	9.58	13.32	5.16	18.5	3.05	3.81
4. Quadrula apiculata aspera	-	-	-	-	-	0.21
5. Quadrula cylindrica	-	0.20	**	-	0.06	0.46
6. Quadrula metanevra	8.38	1.41	**	-	1.89	1.00
7. Quadrula nodulata	5.99	1.28	-	-	0.15	0.48
8. Quadrula pustulosa	4.19	5.61	12.30	13.8	14.31	11.20
9. Amblema plicata	1.20	6.50	7.14	7.2	7.78	11.79
10. Fusconaia ebena	23.35	27.60	40.48	22.7	40.39	35.31
11. Fusconaia subrotunda	0.60	-	**	-	0.21	0.84
12. Fusconaia flava undata	2.40	-	**	-	0.03	0.21
13. Cyclonaias tuberculata	2.99	3.58	1.19	11.3	6.71	6.04
14. Plethobasus cyphyus	-	0.10	-	-	0.03	0.07
15. Plethobasus cooperianus	1.20	-	-	-	-	0.07
16. Pleurobema cordatum	18.56	18.81	14.68	7.2	10.72	7.09
17. Elliptio crassidens	2.40	4.10	0.79	1.2	1.29	1.41
18. Elliptio dilatata	0.60	2.92	2.78	1.2	2.40	1.69
19. Anodonta imbecillis	-	0.13	-	-	-	0.05
20. Anodonta grandis	-	-	-	-	-	0.11
21. Arcidens confragosus	-	-	-	-	0.03	0.11
22. Lasmigona complanata	-	-	-	-	0.03	0.11
23. Ptychobranchus fasciolaris	-	0.03	-	-	-	0.05
24. Obliquaria reflexa	4.19	2.46	5.56	2.4	1.35	3.19
25. Cyprogenia irrorata	-	-	**	-	0.03	-
26. Actinonaias carinata	-	-	-	-	-	0.02
27. Plagiola lineolata	-	3.97	4.76	8.9	4.64	4.86
28. Obovaria olivaria	1.80	-	-	-	-	0.01
29. Obovaria retusa	-	-	-	-	-	0.02
30. Truncilla truncata	2.40	-	-	-	0.09	1.03
31. Truncilla donaciformis	0.60	-	0.40	1.2	0.03	1.35
32. Leptodea fragilis	-	-	-	-	-	0.80
33. Proptera alata	-	0.69	0.40	1.2	0.60	1.51
34. Ligumia recta	-	0.10	**	-	0.18	0.25
35. Lampsilis teres	0.60	-	**	-	-	0.02
36. Lampsilis orbiculata	-	-	-	-	0.03	0.05
37. Lampsilis ovata	-	0.13	-	-	-	0.09
Total Number of Mussels	167	3047	****	****	3340	4384
Total Number of Species	20***	21	22***	13	27***	36

* In van der Schalie, 1939.
** Present, but not in quantitative samples
*** Includes Pleurobema cordatum f. pyramidatum
**** Not reported

Table 6. Age distribution of mussel species in bed located to right of channel from mile 20.5-21.6 (sites 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16).

Species	Age (Years) 1	2	3	4	5	6	7	8	9	10	11	12	>12
1. Megalonaias gigantea	-	-	1	-	-	-	1	-	-	-	-	2	42
2. Tritogonia verrucosa	-	-	-	-	-	1	1	-	-	-	-	-	2
3. Quadrula quadrula	-	-	2	1	-	1	2	1	4	4	2	-	-
4. Quadrula apiculata aspera	-	-	-	-	-	-	-	-	-	1	1	1	1
5. Quadrula cylindrica	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Quadrula metanevra	-	-	-	-	-	-	-	1	1	-	-	-	-
7. Quadrula nodulata	-	1	1	-	-	-	-	-	-	-	-	-	-
8. Quadrula pustulosa	1	1	2	2	2	2	9	9	7	3	2	3	1
9. Amblema plicata	-	8	1	3	2	2	6	12	20	13	18	10	17
10. Fusconaia ebena	2	9	9	3	5	2	3	2	9	5	4	4	22
11. Fusconaia subrotunda	-	-	-	-	-	-	-	-	2	2	4	3	1
12. Fusconaia flava undata	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Cyclonaias tuberculata	-	-	1	1	2	2	4	7	3	8	2	3	-
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-	-	-	-	-	3
16. Pleurobema cordatum	-	-	-	-	-	-	-	-	2	6	4	5	11
17. Elliptio crassidens	-	1	2	-	-	-	4	1	5	2	1	-	-
18. Elliptio dilatata	-	-	-	-	-	-	1	2	7	4	4	3	1
19. Anodonta imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-
20. Anodonta grandis	-	-	-	-	-	-	-	-	-	-	-	1	-
21. Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-
22. Lasmigona complanata	-	-	-	-	-	-	-	-	-	-	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-	-	-	-	-	-
24. Obliquaria reflexa	-	5	7	6	2	-	-	-	-	-	-	-	-
25. Actinonaias carinata	-	-	-	-	-	-	-	-	-	-	-	-	1
26. Plagiola lineolata	-	-	2	-	-	-	2	4	4	11	5	7	6
27. Obovaria olivaria	-	-	-	-	-	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-	-	-	-	-	-
29. Truncilla truncata	-	1	1	-	-	-	-	-	-	-	-	-	-
30. Truncilla donaciformis	2	4	1	-	-	-	-	-	-	-	-	-	-
31. Leptodea fragilis	1	-	-	2	-	-	-	-	-	-	-	-	-
32. Proptera alata	-	-	-	-	-	-	-	1	-	1	-	1	-
33. Ligumia recta	-	-	-	-	-	2	-	-	1	-	-	-	-
34. Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Number of Mussels	6	30	30	18	13	12	33	40	65	60	47	43	107
Total Number of Species	4	8	12	7	5	7	10	10	12	12	11	12	12

Table 7. Age distribution of mussel species in bed located to right of channel from mile 17.6-18.2 (sites 19, 20, 21, 22, 23, 25).

Species	Age (Years) 1	2	3	4	5	6	7	8	9	10	11	12	>12
1. Megalonaias gigantea	-	-	-	-	-	-	-	-	-	2	-	2	14
2. Tritogonia verrucosa	-	1	-	-	-	-	-	1	-	1	-	-	1
3. Quadrula quadrula	-	-	2	1	2	3	4	3	7	4	2	1	1
4. Quadrula apiculata aspera	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Quadrula cylindrica	1	-	2	4	2	1	-	-	-	-	-	-	-
6. Quadrula metanevra	1	-	-	1	-	1	1	2	-	1	-	1	-
7. Quadrula nodulata	-	-	-	1	-	-	-	-	-	-	-	-	-
8. Quadrula pustulosa	-	1	1	-	8	8	13	9	3	1	-	1	-
9. Amblema plicata	-	-	1	4	2	2	2	2	8	7	5	4	5
10. Fusconaia ebena	1	2	5	3	10	6	6	9	1	2	4	1	7
11. Fusconaia subrotunda	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Fusconaia flava undata	-	-	-	-	-	-	-	1	-	-	-	-	-
13. Cyclonaias tuberculata	-	-	-	3	1	2	1	4	4	4	4	2	3
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-	-	-	-	-	-
16. Pleurobema cordatum	-	-	-	-	-	-	3	5	5	5	2	2	6
17. Elliptio crassidens	-	-	-	-	-	-	-	1	1	-	-	-	1
18. Elliptio dilatata	-	-	1	-	-	1	3	2	1	1	1	1	3
19. Anodonta imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-
20. Anodonta grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
21. Arcidens confragosus	-	-	-	-	-	1	-	-	-	-	-	-	-
22. Lasmigona complanata	-	-	-	-	-	-	-	-	-	-	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-	-	-	-	-	1
24. Obliquaria reflexa	-	-	3	6	3	-	-	-	-	-	-	-	-
25. Actinonaias carinata	-	-	-	-	-	-	-	-	-	-	-	-	-
26. Plagiola lineolata	1	-	4	1	-	2	3	3	8	2	2	1	1
27. Obovaria olivaria	-	-	-	-	-	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-	-	-	-	-	-
29. Truncilla truncata	-	-	1	-	1	-	-	1	1	-	-	-	-
30. Truncilla donaciformis	1	-	-	-	-	-	-	-	-	-	-	-	-
31. Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-
32. Proptera alata	-	-	-	-	-	-	-	1	1	1	-	1	-
33. Ligumia recta	-	-	-	-	-	-	-	-	-	-	-	-	-
34. Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Number of Mussels	5	4	20	24	29	27	36	44	40	31	20	17	43
Total Number of Species	5	3	9	9	8	10	9	14	11	12	7	11	11

Table 8. Age distribution of mussel species in bed located to left of channel from mile 14.5-15.0 (sites 26, 28, 29).

Species	Age (Years)												
	1	2	3	4	5	6	7	8	9	10	11	12	>12
1. Megalonaias gigantea	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Tritogonia verrucosa	-	-	-	-	-	1	-	-	-	-	-	-	-
3. Quadrula quadrula	-	-	-	-	-	1	-	-	3	2	-	-	1
4. Quadrula apiculata aspera	-	-	-	-	-	-	-	-	-	-	-	1	-
5. Quadrula cylindrica	-	-	-	-	1	-	-	-	-	-	-	-	-
6. Quadrula metanevra	-	-	2	1	-	1	-	-	-	-	-	-	-
7. Quadrula nodulata	-	-	-	-	-	-	1	-	-	-	-	-	-
8. Quadrula pustulosa	-	-	-	2	4	1	6	4	3	1	1	1	-
9. Amblema plicata	-	-	-	-	-	-	-	-	-	-	2	-	5
10. Fusconaia ebena	-	2	10	6	9	20	12	5	2	-	1	-	6
11. Fusconaia subrotunda	-	-	-	-	-	-	-	-	-	1	1	-	-
12. Fusconaia flava undata	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Cyclonaias tuberculata	-	-	-	-	-	2	-	-	-	1	-	-	1
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-	-	-	-	-	-
16. Pleurobema cordatum	-	-	-	-	-	-	-	-	-	-	-	-	-
17. Elliptio crassidens	-	-	-	-	-	-	-	-	-	-	-	-	-
18. Elliptio dilatata	-	-	-	-	-	-	-	-	-	-	-	-	-
19. Anodonta imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-
20. Anodonta grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
21. Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-
22. Lasmigona complanata	-	-	-	-	-	-	-	-	-	-	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-	-	-	-	-	-
24. Obliquaria reflexa	-	-	1	1	2	2	1	-	1	3	1	-	-
25. Actinonaias carinata	-	-	-	-	-	-	-	-	-	-	-	-	-
26. Plagiola lineolata	-	-	-	2	1	-	-	-	-	-	-	1	-
27. Obovaria olivaria	-	-	-	-	-	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-	-	-	-	-	-
29. Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-	-	-
30. Truncilla donaciformis	-	1	-	-	-	-	-	-	-	-	-	-	-
31. Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-
32. Proptera alata	-	-	-	-	-	-	-	-	-	-	-	-	-
33. Ligumia recta	-	-	-	-	-	-	-	-	-	-	-	-	-
34. Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Number of Mussels	-	3	13	12	17	28	20	9	9	8	6	3	13
Total Number of Species	-	2	3	5	5	7	4	2	4	5	5	3	4

Table 9. Age distribution of mussel species in bed located to right of channel from mile 13.9-14.7 (sites 27, 30, 31, 32, 33, 34, 35, 36).

Species	Age (Years) 1	2	3	4	5	6	7	8	9	10	11	12	>12
1. Megalonaias gigantea	-	-	-	-	-	-	-	-	-	-	-	-	18
2. Tritogonia verrucosa	-	-	-	-	-	1	-	-	1	-	-	-	-
3. Quadrula quadrula	-	-	-	2	-	-	-	-	-	1	-	-	-
4. Quadrula apiculata aspera	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Quadrula cylindrica	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Quadrula metanevra	-	-	-	-	-	-	-	-	-	-	2	-	1
7. Quadrula nodulata	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Quadrula pustulosa	-	1	1	-	1	-	2	4	1	2	1	-	1
9. Amblema plicata	-	-	4	2	1	-	-	-	-	1	2	2	5
10. Fusconaia ebena	1	18	12	16	4	10	5	4	2	4	3	4	7
11. Fusconaia subrotunda	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Fusconaia flava undata	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Cyclonaias tuberculata	-	-	1	-	1	1	2	1	3	1	1	4	2
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-	-	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-	-	-	-	-	-
16. Pleurobema cordatum	-	-	-	-	-	1	2	-	1	5	8	10	11
17. Elliptio crassidens	-	-	-	-	-	-	-	-	-	-	-	-	-
18. Elliptio dilatata	-	-	-	-	-	-	-	-	-	-	-	-	-
19. Anodonta imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-
20. Anodonta grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
21. Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-
22. Lasmigona complanata	-	-	-	-	-	-	-	-	-	-	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-	-	-	-	-	-
24. Obliquaria reflexa	-	-	1	-	-	-	-	-	-	-	-	-	-
25. Actinonaias carinata	-	-	-	-	-	-	-	-	-	-	-	-	-
26. Plagiola lineolata	-	-	-	-	1	1	2	4	3	2	3	1	2
27. Obovaria olivaria	-	-	-	-	-	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-	-	-	-	-	-
29. Truncilla truncata	-	1	-	2	-	-	-	-	-	-	-	-	-
30. Truncilla donaciformis	1	1	1	-	-	-	-	-	-	-	-	-	-
31. Leptodea fragilis	-	-	-	-	1	-	-	-	-	-	-	-	-
32. Proptera alata	-	-	-	-	-	-	-	-	1	-	1	-	-
33. Ligumia recta	-	-	-	-	-	-	-	-	-	-	-	-	-
34. Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-	-	-	-	1	1
36. Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Number of Mussels	2	21	20	22	9	14	13	13	12	16	21	22	48
Total Number of Species	2	4	6	4	6	5	5	4	7	7	8	6	9

Table 10. Age distribution of mussel species in bed located to right of channel from mile 13.5-13.8 (sites 38, 40, 41, 42).

Species	Age (Years) 1	2	3	4	5	6	7	8	9	10	11	12	>12
1. Megalonaias gigantea	-	1	-	-	-	-	1	-	1	1	1	1	9
2. Tritogonia verrucosa	-	-	1	-	-	-	-	-	-	-	-	-	-
3. Quadrula quadrula	-	-	4	1	-	-	5	4	2	-	1	-	-
4. Quadrula apiculata aspera	-	-	-	-	-	-	1	-	-	-	-	-	-
5. Quadrula cylindrica	-	-	-	-	1	1	-	-	-	-	-	-	-
6. Quadrula metanevra	-	-	-	-	-	-	-	-	-	-	-	-	1
7. Quadrula nodulata	1	1	-	1	-	-	-	-	-	-	-	-	-
8. Quadrula pustulosa	1	1	2	2	3	3	5	2	1	3	1	1	-
9. Amblema plicata	-	-	3	1	-	2	-	-	3	2	2	-	2
10. Fusconaia ebena	3	11	4	5	4	7	-	4	2	2	2	3	5
11. Fusconaia subrotunda	-	-	-	-	-	-	-	-	-	-	-	-	6
12. Fusconaia flava undata	-	-	-	-	-	-	-	-	-	-	-	-	1
13. Cyclonaias tuberculata	-	-	-	-	-	-	1	2	1	-	-	1	1
14. Plethobasus cyphyus	-	-	-	-	-	-	-	-	1	-	-	-	-
15. Plethobasus cooperianus	-	-	-	-	-	-	-	-	-	-	-	-	-
16. Pleurobema cordatum	-	-	-	1	-	-	-	-	1	5	7	4	12
17. Elliptio crassidens	-	-	-	-	-	-	-	-	-	1	-	-	1
18. Elliptio dilatata	-	-	-	-	-	-	-	-	1	1	-	-	3
19. Anodonta imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-
20. Anodonta grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
21. Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-
22. Lasmigona complanata	-	-	-	-	-	-	-	-	-	-	-	-	-
23. Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-	-	-	-	-	-
24. Obliquaria reflexa	-	2	5	2	-	1	1	-	-	-	-	-	-
25. Actinonaias carinata	-	-	-	-	-	-	-	-	-	-	-	-	-
26. Plagiola lineolata	-	1	3	-	-	2	3	1	1	2	-	1	2
27. Obovaria olivaria	-	-	-	-	-	-	-	-	-	-	-	-	-
28. Obovaria retusa	-	-	-	-	-	-	-	-	-	-	-	-	-
29. Truncilla truncata	-	1	2	4	-	-	-	-	-	-	-	-	-
30. Truncilla donaciformis	1	3	1	-	-	-	-	-	-	-	-	-	-
31. Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-
32. Proptera alata	-	-	1	-	1	-	1	1	2	-	-	-	4
33. Ligumia recta	-	-	-	-	-	-	-	-	-	-	-	-	-
34. Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-
35. Lampsilis orbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-
36. Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Number of Mussels	6	21	26	17	9	16	18	14	16	17	14	11	47
Total Number of Species	4	8	10	8	4	6	8	6	11	8	6	6	12

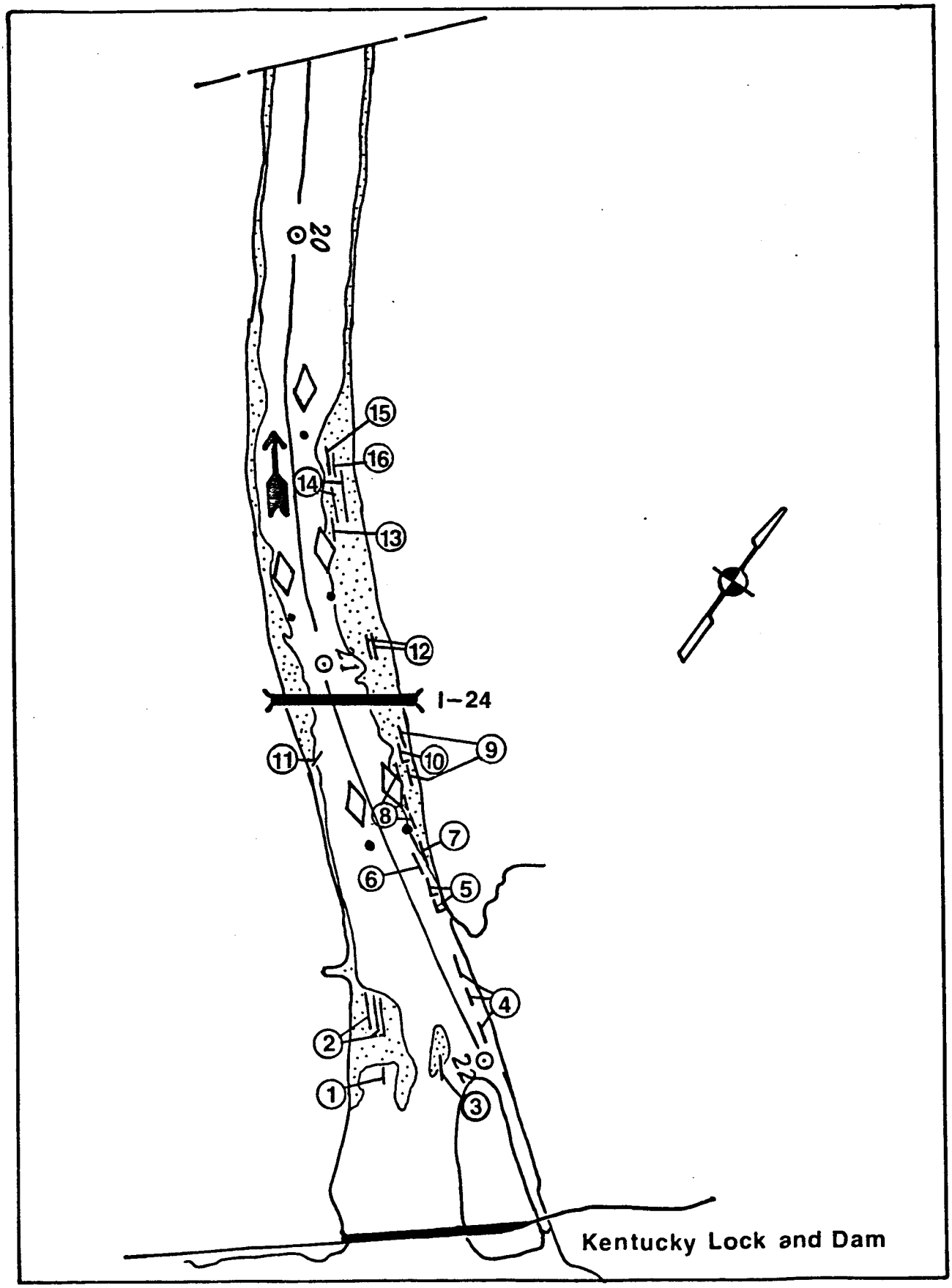

Fig. 1. Sample sites on Tennessee River between miles 22.4-19.5. (Dive sites are 1, 3, 4, 5, 7, 10, 11, 13, 16).

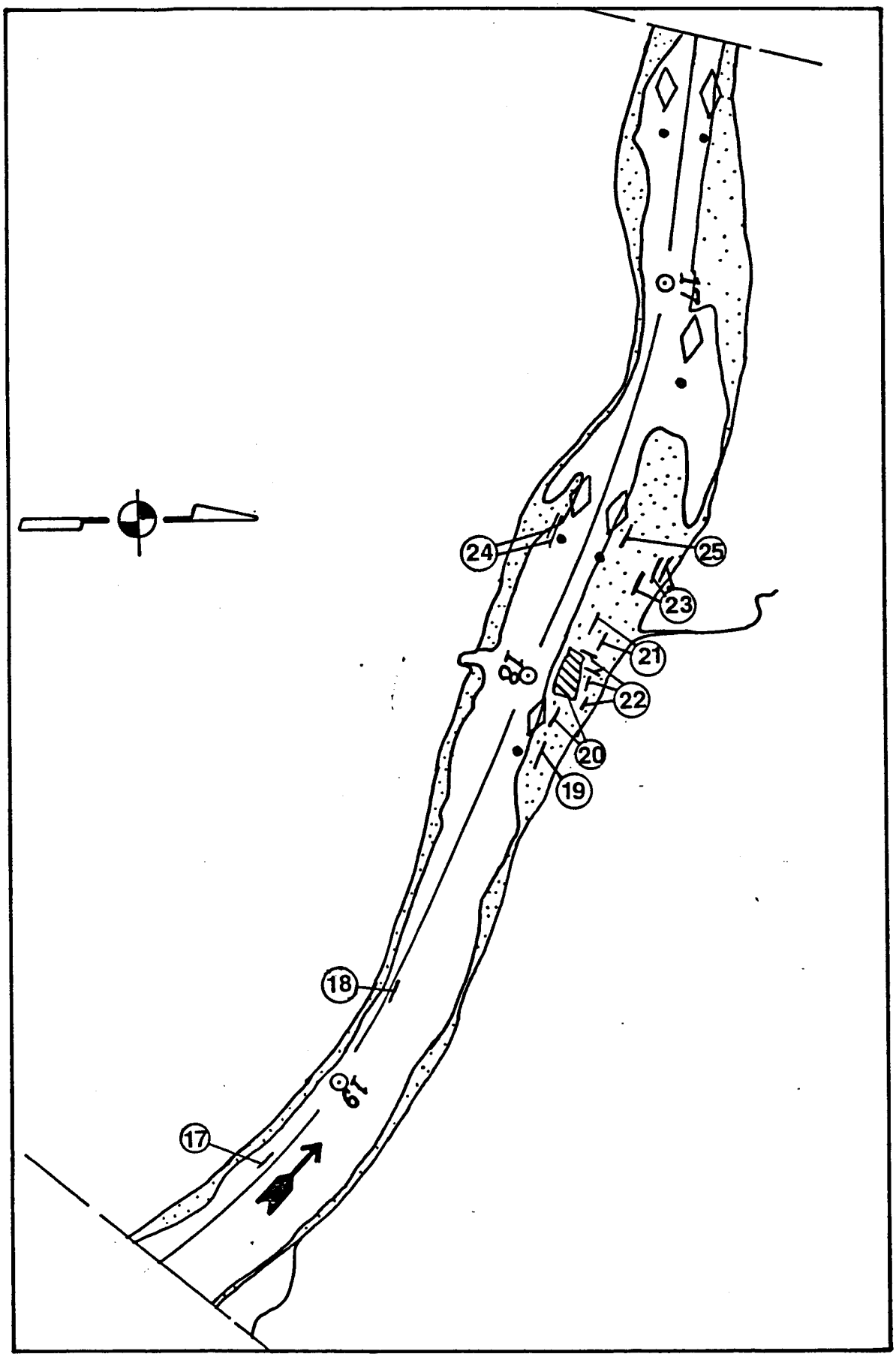

Fig. 2. Sample sites on Tennessee River between miles 19.6-16.5. (Dive sites are 20, 22, 25).

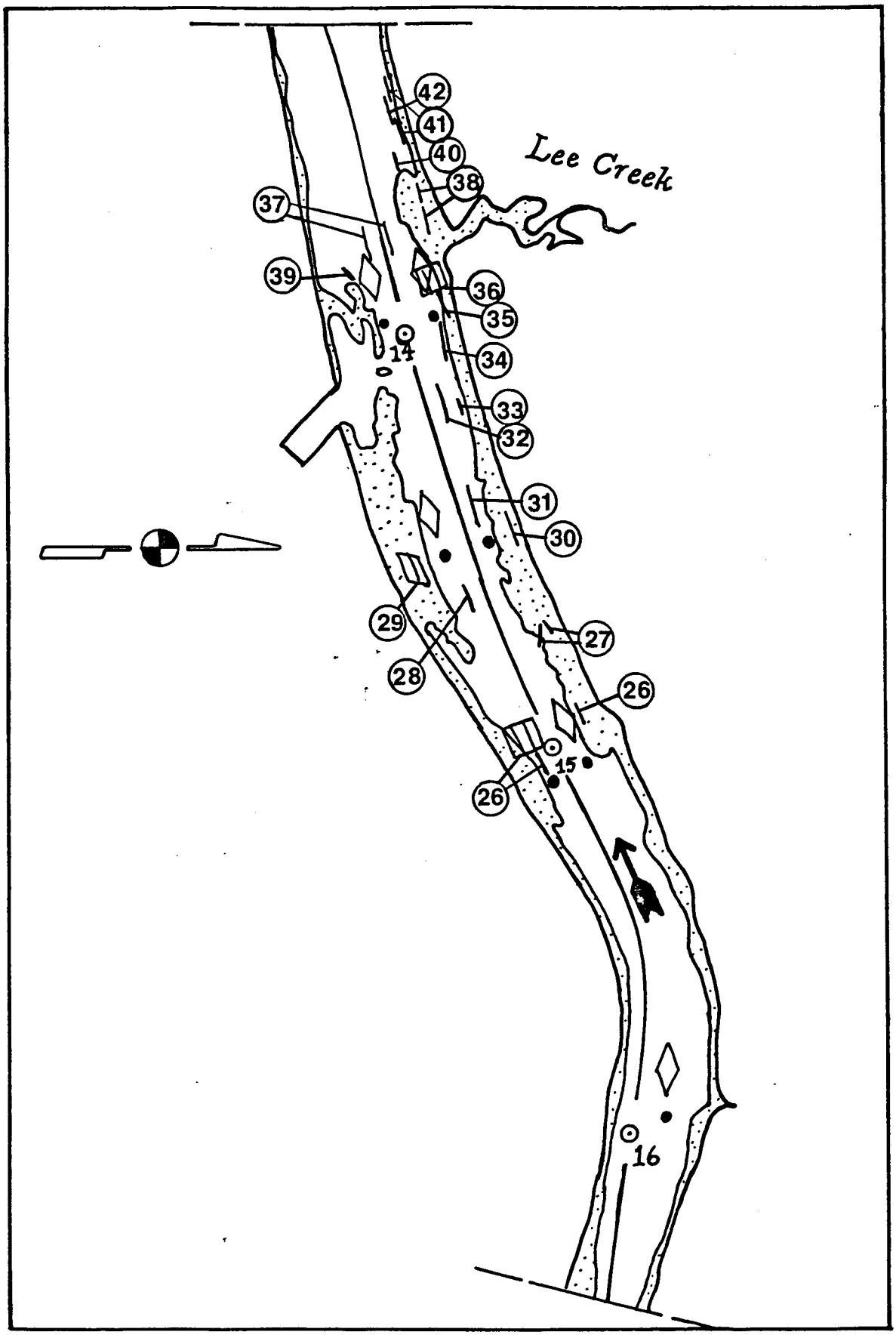

Fig. 3. Sample sites on Tennessee River between miles 16.5-13.2. (Dive sites are 27, 33, 39, 40, 42).

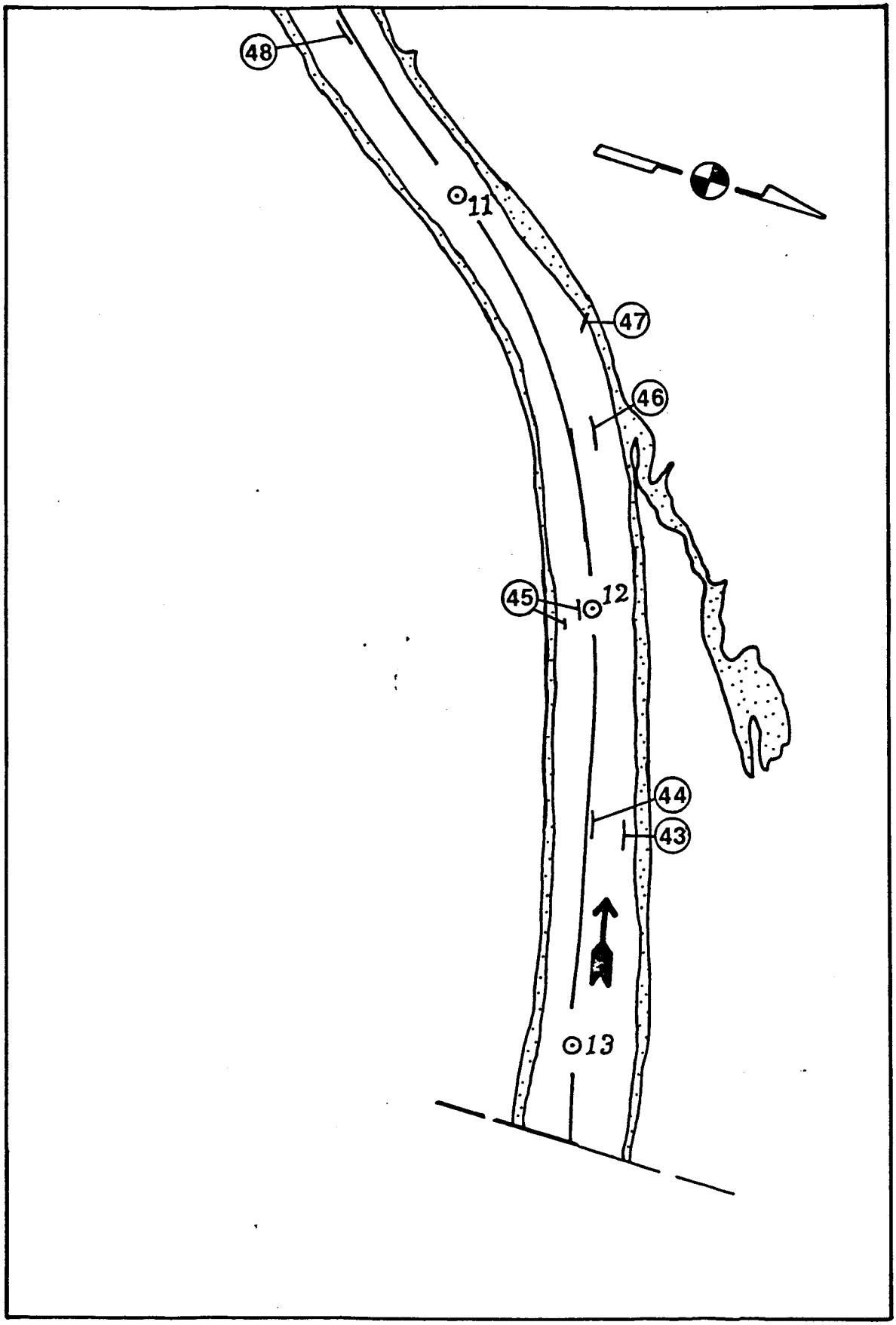

Fig. 4. Sample sites on Tennessee River between miles 13.2-10.5. (Dive sites are 45, 47).

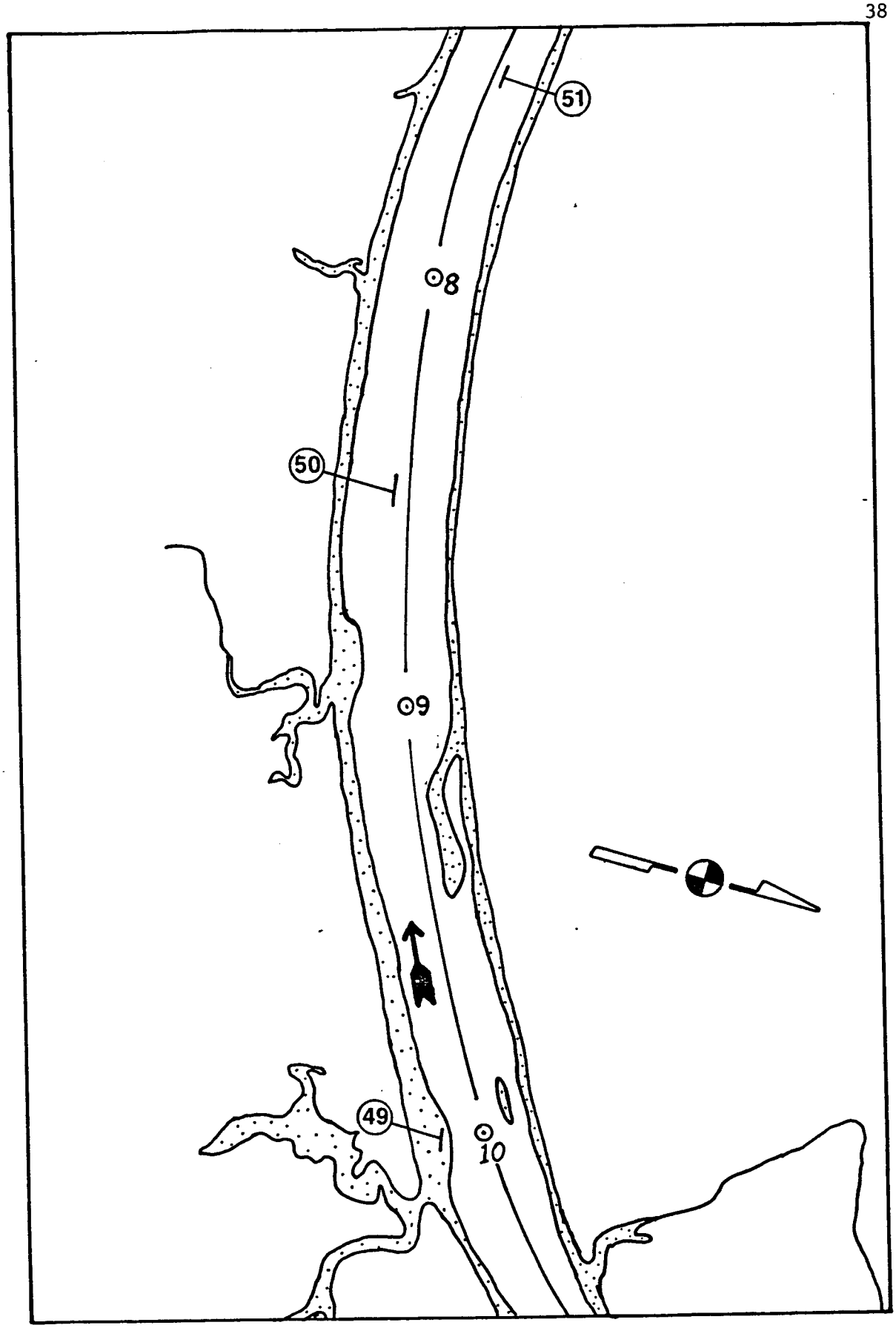

Fig. 5. Sample sites on Tennessee River between miles 10.5-7.4. (Dive site is 49).

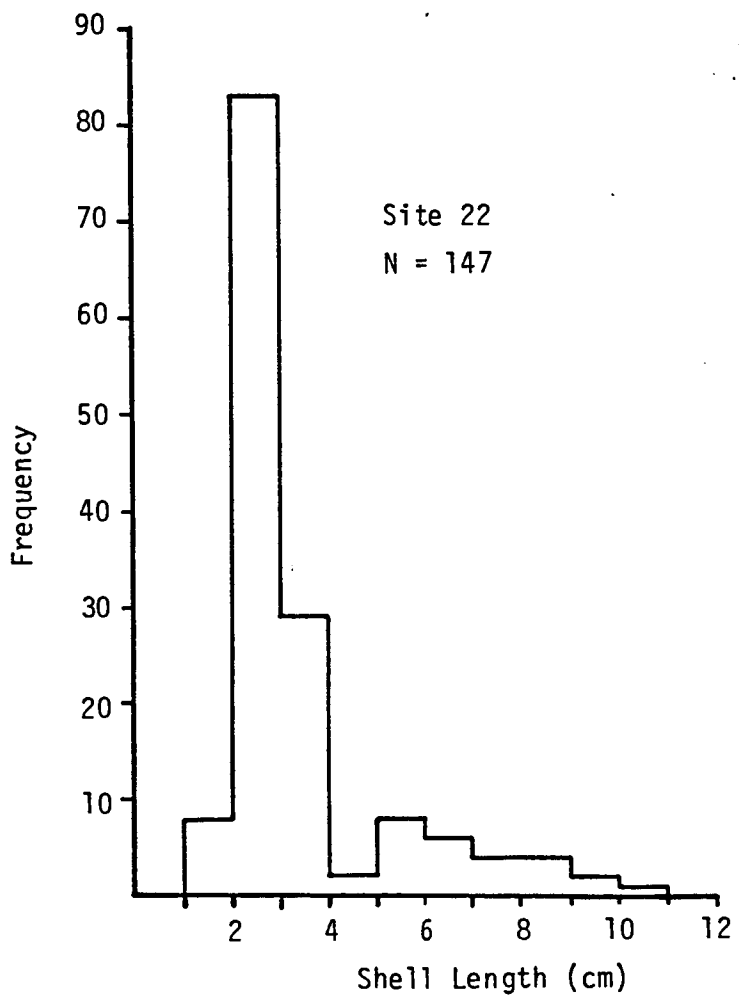

Fig. 6. Length frequency distribution of a sample of Fusconaia ebena taken 10 m from shore at Site 22, TRM 17.8, in a 5 m^2 sample.

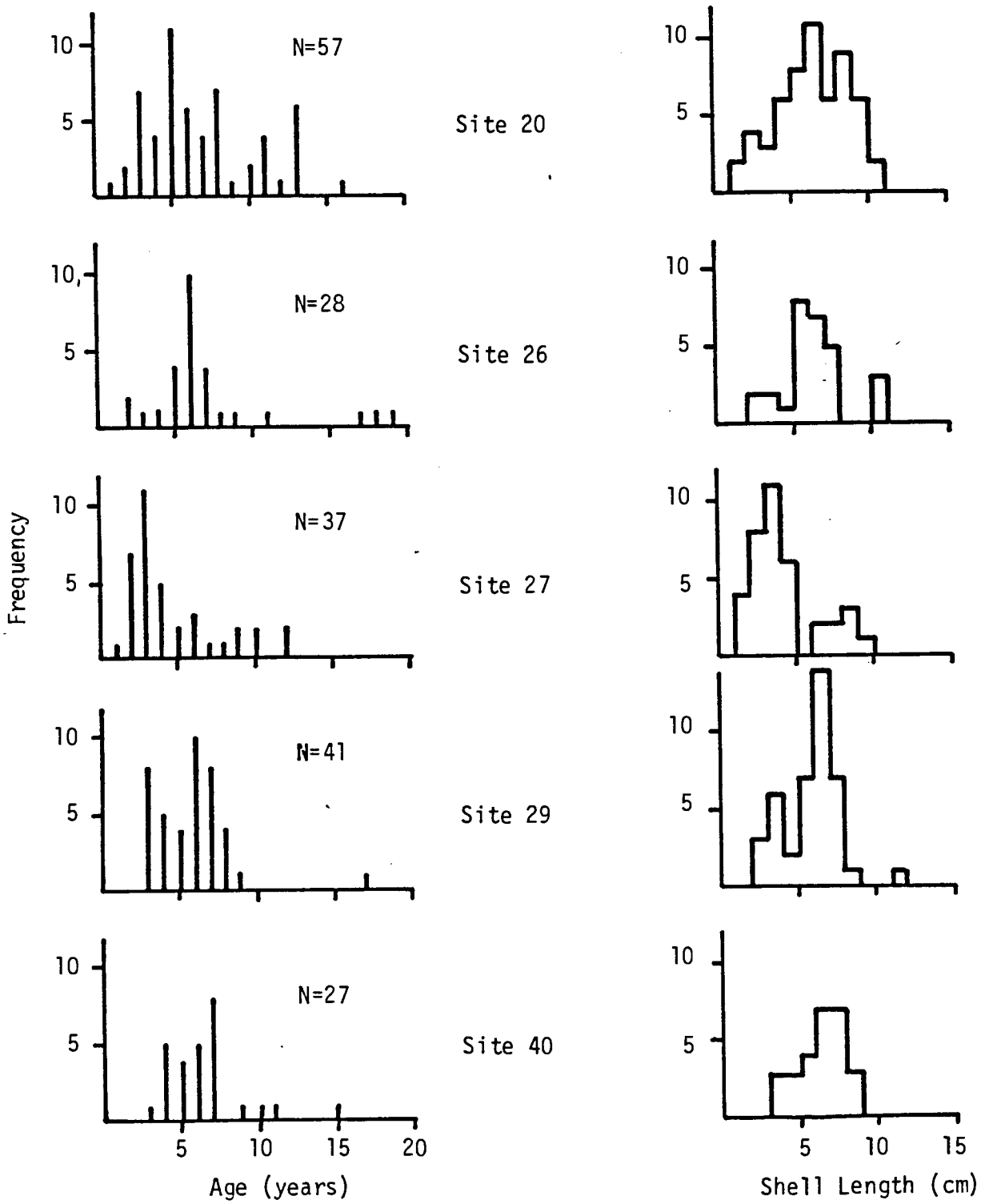

Fig. 7. Age and shell length distribution of Fusconaia ebena from 5 sites in the Kentucky Dam Tailwaters, Tennessee River.

REFERENCES

Bates, John M. 1975. Unpublished Personal Services Contract: Overbank and Tailwater Studies. Tennessee Valley Authority Contract No. TV-38606A. Ecological Consultants, Inc., Ann Arbor, Michigan. 158 pp.

Branson, Branley A., Donald F. Harker, Jr., Jerry M. Baskin, Max E. Medley, Donald L. Batch, Melvin L. Warren, Jr., Wayne H. Davis, Wayne C. Houtcooper, Burt Monroe, Jr., Loy R. Phillippe, and Paul Cupp. 1981. Endangered, threatened, and rare animals and plants of Kentucky. Transactions Kentucky Academy of Science. 42(3-4):77-89.

Isom, Billy G. 1969. The mussel resource of the Tennessee River. Malacologia 7(2-3): 397-425.

Morrison, J. P. E. 1969. The earliest names for North American naiads. American Malacological Union Ann. Rept. 1969: 22-24.

TVA. 1978. Tennessee Valley Authority unpublished data.

Sickel, James B. 1981. Unpublished museum records, Murray State University Mollusk Museum, Murray, Kentucky.

Sickel, James B. 1982. A survey of the freshwater mussels of the lower Cumberland River from Barkley Dam tailwater downstream to the Ohio River. Report to the Nashville District Army Corps of Engineers, Contract No. DACW62-81-C-0295. 24 pp.

Stansbery, David H. 1970. Eastern freshwater mollusks (I). The Mississippi and St. Lawrence River Systems. In Arthur H. Clarke, editor. Proceedings of the American Malacological Union symposium on rare and endangered mollusks. Malacologia. 10(1):9-22.

U.S. Fish and Wildlife Service. 1976. Endangered and threatened wildlife and plants. Federal Register. 4(115): 24062-24067.

van der Schalie, Henry. 1939. Additional notes on the Naiades (fresh-water mussels) of the lower Tennessee River. American Midland Naturalist 22(2): 452-457.

Williams, John C. 1969. Mussel fishery investigation Tennessee, Ohio and Green Rivers. Final Report . Murray State University Biological Station. Report to Kentucky Department of Fish and Wildlife Resources, Project No. 4-19-R. 107 pp.